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A STUDY OF CORRELATIONS OF OZONE AND SULFUR DIOXIDE

L. F. Ballard, et al

Research Triangle Institute

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RESEARCH TRIANGLE INSTITUTE

FINAL REPORT

RTI PROJECT 41U-98-93

A STUDY OF CORRELATIONS OF OZONE AND SULFUR DIOXIDE

by

L. F. Ballard

L. K. Matus

Prepared for

Environmental Protection Agency
Contract No. 68-02-0257

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A STUDY OF CORRELATIONS OF OZONE AND SULFUR DIOXIDE

This report describes the results of a data analysis study to determine the correlation between ozone (O_3) and sulfur dioxide (SO_2) concentrations in ambient air using data that had been obtained previously in Los Angeles and St. Louis (Refs. 1-3). Sulfur dioxide concentrations were determined by the flame photometric detector method. Ozone concentrations were determined by the chemiluminescent reaction between ozone and ethylene. These methods are assumed to have a high degree of specificity under the prevailing ambient air conditions and no corrections for instrument interferences are applied.

Wilson et al. (Ref. 4) demonstrated the effect of SO_2 on oxidant formation in environmental chambers. The effect was small but statistically significant. The mechanism was postulated to be the slow reaction involving SO_2 and oxides of nitrogen.

Not having an established gas phase reaction model as a basis for relating SO_2 and O_3 in this study, a series of simple linear regressions were performed to test or determine the significance of a relationship if it exists. Data sets consisted of hourly averages obtained at the same time each day. A normal distribution of error was assumed.

Results of a linear correlation of the form

$$[SO_2] = a_1[O_3] + a_2$$

are shown in Tables I-III for data obtained in Los Angeles and St. Louis, Phase I and St. Louis, Phase II. The upper part of the tables includes each of the 24 hourly averages using all the data with no constraints. The lower part includes data for 1000 to 1700 hours only when the

TABLE I

CORRELATION BETWEEN SULPHUR DIOXIDE AND OZONE

IN LOS ANGELES: $[SO_2] = a_1[O_3] + a_2$

4 SEP 70 TO 1 DEC 70

Hour	Correlation Coefficient	Slope	Intercept (ppm · ozone)	Case Count
NO STIPULATIONS:				
0000	.103	.128	.006	73
0100	.017	.019	.007	73
0200	-.060	-.061	.007	73
0300	-.041	-.033	.007	73
0400	-.044	-.034	.007	73
0500	-.103	-.094	.007	72
0600	-.104	-.162	.008	72
0700	-.110	-.293	.009	72
0800	-.238	-.677*	.011	71
0900	-.284	-.402*	.013	66
1000	.102	.056	.008	56
1100	.406	.165*	.005	56
1200	.398	.142*	.004	56
1300	.241	.110	.008	57
1400	.463	.166*	.004	58
1500	.449	.134*	.003	68
1600	.377	.097*	.004	72
1700	.420	.142*	.002	73
1800	.277	.129*	.003	73
1900	.342	.242*	.003	73
2000	.280	.259*	.004	73
2100	.215	.176	.004	73
2200	.128	.133	.005	73
2300	.153	.183	.005	73
STIPULATIONS - .020<NO2<.040, and RH<70:				
1000	-.981	-.369	.001	3
1100	.227	.054	-.004	5
1200	.084	.036	-.005	5
1300	.169	.022	-.005	6
1400	.934	.349*	-.009	5
1500	.878	.107*	-.004	5
1600	.544	.130	-.005	7
1700	.769	.329	-.004	6

* Significant at the 5% level.

TABLE II

CORRELATION BETWEEN SULPHUR DIOXIDE AND OZONE

IN ST LOUIS I: $[SO_2] = a_1[O_3] + a_2$

13 MAY 71 TO 17 AUG 71

HOUR	CORRELATION COEFFICIENT	SLOPE	INTERCEPT (ppm · ozone)	CASE COUNT
NO STIPULATIONS:				
0000	.037	.024	.003	85
0100	-.020	-.009	.002	85
0200	.169	.080	.000	85
0300	.076	.047	.002	85
0400	.172	2.343	-.056	85
0500	.099	.063	.002	85
0600	.070	.059	.002	85
0700	-.231	-.255	.008	72
0800	-.330	-3.903*	.067	81
0900	-.268	-.270*	.018	76
1000	-.138	-.180	.021	74
1100	-.130	-.175	.023	76
1200	-.011	-.010	.010	79
1300	-.101	-.080	.011	79
1400	.015	.011	.007	77
1500	.203	.078	.000	79
1600	.294	.133*	-.002	81
1700	.172	.108	.001	84
1800	.101	.074	.004	85
1900	.066	.051	.005	85
2000	.040	.036	.005	85
2100	.149	.116	.004	84
2200	.055	.047	.005	84
2300	-.020	-.020	.006	84
STIPULATIONS - .020<NO2<.040. and RH<70:				
1000	.849	.677	-.016	5
1100	.071	.304	.025	3
1200	1.000	1.182	.046	2
1300	-.866	-3.181	.161	4
1400	-.119	-.040	.013	6
1500	.554	.156	-.005	5
1600	.375	.048	.001	9
1700	.048	.026	.004	13

* Significant at the 5% level.

TABLE III

CORRELATION BETWEEN SULPHUR DIOXIDE AND OZONE

IN ST. LOUIS II: $[SO_2] = a_1[O_3] + a_2$

7 OCT 71 TO 20 DEC 71

HOUR	CORRELATION COEFFICIENT	SLOPE	INTERCEPT	CASE COUNT
NO STIPULATIONS:				
0000	-.046	-.079	.007	64
0100	-.112	-.188	.007	64
0200	-.124	-.129	.005	64
0300	-.185	-.180	.005	64
0400	-.119	-.110	.004	64
0500	-.203	-.149	.005	64
0600	-.185	-.406	.007	64
0700	-.159	-.322	.005	59
0800	-.165	-.374	.007	55
0900	-.150	-.373	.011	51
1000	-.252	-.590	.019	55
1100	-.286	-.591*	.022	62
1200	-.184	-.216	.014	63
1300	-.072	-.085	.012	63
1400	-.288	-.271*	.015	63
1500	-.333	-.342*	.015	63
1600	-.284	-.280*	.012	64
1700	-.227	-.225	.008	64
1800	-.146	-.203	.006	64
1900	-.173	-.275	.006	64
2000	-.146	-.130	.005	64
2100	.003	.004	.005	64
2200	-.038	-.043	.005	64
2300	.131	.174	.004	64
STIPULATIONS - .020<NO2<.040, and RH<70:				
1000	-.726	-.940*	.025	11
1100	-.344	-.333	.015	10
1200	.109	.070	.006	9
1300	-.380	-.285	.016	15
1400	-.130	-.090	.013	19
1500	-.303	-.271	.010	22
1600	-.289	-.210	.009	22
1700	-.126	-.050	.002	16

* Significant at the 5% level.

relative humidity was less than 70 percent and the NO_2 concentration was between 0.02 and 0.04 ppm. These added constraints increase the correlation coefficient, but the reduction in the number of cases gives a net loss of significance. Asterisks are placed beside those coefficients significantly different from zero at the 5% level. The relatively poor reliability of the SO_2 instrument response during the St. Louis operation would be expected to limit the maximum correlation that could be observed (Ref. 3). High correlation requires that the variability due to instrument error be small compared to the average value and range of SO_2 concentration. In Appendices A, B, and C the hourly averages and standard deviations are given for O_3, SO_2, NO_2, solar radiation, and relative humidity. SO_2 averages are in the neighborhood of 0.01 ppm. The instrument reproducibility as determined by calibrations at two-day intervals was much greater than 0.01 ppm so that low correlations can be expected.

The marginal significance of the correlation and the difference in the sign of the coefficient from morning to afternoon are the dominant features of Tables I-III. To provide additional insight into this correlation a multiple linear regression analysis was performed including the five variables indicated above. The regression equation is written as a linear prediction model for O_3 using these variables

$$[O_3] = a_1[SO_2] + a_2[NO_2] + a_3[R.H.] + a_4[Sol.Rad.] + a_5 .$$

The multiple correlation coefficients and standard error of estimates for this predictor are given in Table IV. The highest correlation and the lowest prediction error are obtained for the St. Louis II data.

This is largely attributed to improved measurements of NO_2 concentration by the chemiluminescent method. In this case the error of estimate varies from .006 to .014 ppm which is comparable to the reproducibility of many ozone instruments.

The correlation of this predictor with ozone concentrations is significant in most cases at the 1% level (indicated by two asterisks in Table IV). The solar radiation coefficient is the most significant term, achieving the 1% level in all cases. The SO_2 coefficient is not significantly different from zero at the 5% level in any of the St. Louis data. In Los Angeles the SO_2 coefficient is significant at the 5% level at 1200, 1400, 1500, and 1700 hours; the coefficient ranges between 0.33 and 0.68.

Several other prediction models were tested as indicated in Table V and Table VI. In model II the SO_2 term was removed. In model III the NO_2 term was removed. Models IV and V make use of the ratios SO_2/NO_2 and SO_2/RH. None of these variations in the model form resulted in a significantly better predictor of the O_3 concentrations. Individual regression coefficients other than solar radiation were significant at the 5% level at only one or two hours of the day. Greatest significance was usually found near the middle of the day.

In summary, a linear relation between the concentration of O_3 and SO_2 in ambient air is suggested by the LA data only. The multiple correlations attempted are not consistently significant. Interpretation of the relation is difficult because of the dependence of these variables upon gas phase reactions involving NO_2, water vapor and other gases as well as the variability of instrumentation response and the uncertainty of SO_2 emission source distribution effects.

TABLE IV

MULTIPLE CORRELATION ANALYSES

$O_3 = a_1[SO_2] + a_2[NO_2] + a_3[RH] + a_4[SOL\ RAD] + a_5$

CORRELATION COEFFICIENT

HOUR	LOS ANGELES 4 SEP 70 TO 1 DEC 70	ST. LOUIS I 13 MAY 71 TO 17 AUG 71	ST. LOUIS II 7 OCT 71 TO 20 DEC 71
1000	.459	.449*	.725**
1100	.561*	.506**	.749**
1200	.709**	.393	.741**
1300	.724**	.444*	.719**
1400	.717**	.305	.715**
1500	.738**	.428*	.836**
1600	.746**	.502**	.832**
1700	.740**	.494**	.774**
	STANDARD ERROR OF ESTIMATE		
1000	.017	.015	.006
1100	.025	.014	.008
1200	.029	.017	.012
1300	.029	.017	.012
1400	.032	.021	.014
1500	.027	.021	.010
1600	.024	.019	.010
1700	.015	.018	.009

* Significant at the 5% level.

** Significant at the 1% level.

TABLE V

MULTIPLE CORRELATION ANALYSES

ST. LOUIS II

7 OCT 71 TO 20 DEC 71

CORRELATION COEFFICIENT*

HOUR	I	II	III	IV	V
1000	.725	.607	.609	.573	.587
1100	.749	.754	.792	.771	.700
1200	.741	.840	.733	.750	.700
1300	.719	.891	.791	.753	.768
1400	.715	.750	.704	.731	.730
1500	.836	.816	.785	.794	.818
1600	.832	.782	.781	.792	.796
1700	.775	.728	.728	.728	.711

* I: $O_3 = a_1[SO_2] + a_2[NO_2] + a_3[RH] + a_4[\text{SOL RAD}] + a_5$

II: $O_3 = a_1[NO_2] + a_2[RH] + a_3[\text{SOL RAD}] + a_4$

III: $O_3 = a_1[SO_2] + a_2[RH] + a_3[\text{SOL RAD}] + a_4$

IV: $O_3 = a_1[SO_2/NO_2] + a_2[RH] + a_3[\text{SOL RAD}] + a_4$

V: $O_3 = a_1[SO_2/NO_2] + a_2[SO_2/RH] + a_3[\text{SOL RAD}] + a_4$

TABLE VI

MULTIPLE CORRELATION ANALYSES

ST. LOUIS II

7 OCT 71 TO 20 DEC 71

STANDARD ERROR OF ESTIMATE*

(ppm . ozone)

HOUR	I	II	III	IV	V
1000	.006	.008	.007	.007	.007
1100	.008	.008	.007	.008	.009
1200	.011	.009	.012	.012	.013
1300	.012	.008	.011	.012	.011
1400	.014	.013	.014	.014	.014
1500	.010	.010	.012	.012	.011
1600	.010	.011	.011	.011	.011
1700	.009	.009	.010	.010	.010

* I: $O_3 = a_1[SO_2] + a_2[NO_2] + a_3[RH] + a_4[\text{SOL RAD}] + a_5$

II: $O_3 = a_1[NO_2] + a_2[RH] + a_3[\text{SOL RAD}] + a_4$

III: $O_3 = a_1[SO_2] + a_2[RH] + a_3[\text{SOL RAD}] + a_4$

IV: $O_3 = a_1[SO_2/NO_2] + a_2[RH] + a_3[\text{SOL RAD}] + a_4$

V: $O_3 = a_1[SO_2/NO_2] + a_2[SO_2/RH] + a_3[\text{SOL RAD}] + a_4$

Future efforts to understand this relationship should include the development of a prediction model based on postulated gas phase reactions. Recognizing that ambient air data is the true test for such a model, field data such as that in this study should be utilized. High correlation is not to be expected if the variability due to instrument error is large relative to the average value and range of SO_2 and O_3 concentrations. Significance of the statistical comparison of the model and instrumental data would be enhanced by independent tests indicating both the nature of the distribution function and magnitude of the expected deviation attributable to the error in instrument output.

REFERENCES

1. L. F. Ballard, J. B. Tommerdahl, C. E. Decker, T. M. Royal, and D. R. Nifong, "Field Evaluation of New Air Pollution Monitoring Systems: Los Angeles Study," Interim Report, April 14, 1971, Research Triangle Institute, NAPCA Contract CPA 70-101.

2. L. F. Ballard, J. B. Tommerdahl, C. E. Decker, T. M. Royal, and L. K. Matus, "Field Evaluation of New Air Pollution Monitoring Systems: St. Louis Study, Phase I," Interim Report, August 18, 1971, Research Triangle Institute, EPA Contract CPA 70-101.

3. C. E. Decker, T. M. Royal, J. B. Tommerdahl, and L. K. Matus, "Field Evaluation of New Air Pollution Monitoring Systems: St. Louis, Phase II," Interim Report, December 20, 1971, Research Triangle Institute, EPA Contract CPA 70-101.

4. W. E. Wilson, Jr., A. Levy, and D. B. Wimmer, "A Study of SO_2 in Photochemical Smog. II. Effect of SO_2 on Oxidant Formation in Photochemical Smog," J. Air Pollution Control, Vol. 22, No. 1, 27 (January 1972).

APPENDIX A
STATISTICAL AIR QUALITY DATA IN LOS ANGELES
4 SEP 70 TO 1 DEC 70

HOURS --		0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100
OZONE	AVERAGE (PPM)	.002	.002	.003	.003	.003	.001	.000	.001	.006	.018	.038	.058
	STANDARD DEVIATION	.007	.008	.009	.010	.009	.005	.003	.003	.007	.016	.029	.039
	CASE COUNT	76	76	76	76	75	75	75	73	70	63	65	65
SO2	AVERAGE (PPM)	.007	.007	.007	.007	.007	.007	.009	.011	.011	.010	.012	.013
	STANDARD DEVIATION	.008	.008	.008	.008	.008	.008	.008	.009	.009	.009	.012	.014
	CASE COUNT	82	82	82	82	81	81	81	80	79	74	74	71
NO2	AVERAGE (PPM)	.085	.084	.082	.079	.077	.083	.100	.121	.125	.127	.112	.094
	STANDARD DEVIATION	.046	.046	.045	.045	.043	.043	.052	.069	.078	.084	.069	.054
	CASE COUNT	70	70	70	70	69	69	69	66	58	61	58	56
SOL. RAD.	AVERAGE (LANGLEYS)	-.001	-.000	-.000	-.000	-.000	.004	.083	.255	.439	.588	.699	.746
	STANDARD DEVIATION	.003	.003	.002	.002	.003	.008	.059	.128	.173	.199	.210	.220
	CASE COUNT	86	86	86	86	85	85	85	84	86	87	87	87
RH	AVERAGE (PERCENT)	57.950	58.124	58.111	57.530	57.832	57.974	57.956	56.284	52.125	47.793	43.714	40.735
	STANDARD DEVIATION	18.121	17.630	17.720	18.642	18.845	18.493	18.455	18.725	19.431	19.580	17.793	17.260
	CASE COUNT	86	86	86	86	85	85	85	84	86	87	87	87

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HOURS --		1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
OZONE	AVERAGE (PPM)	.066	.061	.049	.033	.020	.014	.007	.005	.004	.004	.003	99.999
	STANDARD DEVIATION	.047	.045	.040	.035	.025	.020	.013	.010	.009	.008	.007	99.999
	CASE COUNT	66	69	72	75	76	76	76	76	76	76	76	0
SO2	AVERAGE (PPM)	.016	.014	.010	.008	.006	.005	.004	.005	.005	.005	.006	99.999
	STANDARD DEVIATION	.021	.016	.012	.010	.008	.007	.008	.008	.008	.008	.008	99.999
	CASE COUNT	73	74	81	82	82	82	83	83	82	82	82	0
NO2	AVERAGE (PPM)	.087	.080	.080	.086	.083	.083	.080	.080	.081	.081	.083	99.999
	STANDARD DEVIATION	.055	.044	.039	.040	.040	.040	.036	.039	.042	.040	.041	99.999
	CASE COUNT	59	63	66	70	71	71	71	70	70	70	70	0
SOL. RAD.	AVERAGE (LANGLEYS)	.696	.614	.463	.277	.109	.022	-.001	-.001	-.001	-.001	-.001	99.999
	STANDARD DEVIATION	.245	.248	.238	.215	.105	.034	.003	.004	.004	.003	.003	99.999
	CASE COUNT	87	87	87	87	87	87	87	87	86	86	86	0
RH	AVERAGE (PERCENT)	41.493	42.406	44.303	46.703	49.416	51.805	53.840	55.107	56.742	57.278	57.592	99.999
	STANDARD DEVIATION	15.913	16.078	16.475	16.769	17.605	18.232	18.861	19.077	18.592	18.414	18.422	99.999
	CASE COUNT	87	87	87	87	87	87	87	87	86	86	86	0

APPENDIX B

STATISTICAL AIR QUALITY DATA IN ST. LOUIS I

13 MAY71 TO 17 AUG71

HOURS --		0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100
OZONE	AVERAGE (PPM)	.015	.015	.014	.014	.013	.012	.009	.011	.021	.034	.044	.049
	STANDARD DEVIATION	.018	.019	.020	.020	.019	.019	.015	.015	.017	.017	.018	.018
	CASE COUNT	89	89	89	89	89	89	89	76	85	81	82	83
SO2	AVERAGE (PPM)	.003	.002	.002	.004	-.022	.003	.003	.006	-.010	.009	.013	.014
	STANDARD DEVIATION	.013	.011	.012	.015	.254	.012	.013	.018	.187	.017	.023	.024
	CASE COUNT	91	91	91	91	91	91	91	78	90	84	81	84
NO2	AVERAGE (PPM)	.048	.041	.029	.022	.017	.019	.034	.039	.035	.020	.012	.009
	STANDARD DEVIATION	.040	.037	.032	.029	.027	.026	.032	.036	.036	.023	.023	.024
	CASE COUNT	62	62	62	62	62	62	62	49	59	60	58	59
SOL. RAD.	AVERAGE (LANGLEYS)	0.000	0.000	0.000	0.000	0.000	.000	.054	.213	.387	.558	.731	.832
	STANDARD DEVIATION	0.000	0.000	0.000	0.000	0.000	.002	.028	.094	.155	.215	.247	.280
	CASE COUNT	96	96	96	96	96	96	96	96	96	96	96	96
RH	AVERAGE (PERCENT)	69.026	70.493	71.527	72.670	74.250	75.106	75.594	70.984	64.323	58.818	54.980	51.534
	STANDARD DEVIATION	15.637	16.098	15.986	16.024	15.982	15.988	16.264	15.944	15.497	15.147	14.868	14.915
	CASE COUNT	96	96	96	96	96	96	96	96	96	96	96	96

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HOURS --		1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
OZONE	AVERAGE (PPM)	.057	.059	.062	.062	.058	.051	.047	.038	.022	.015	.013	.013
	STANDARD DEVIATION	.020	.021	.021	.023	.023	.022	.021	.019	.018	.017	.017	.017
	CASE COUNT	86	85	83	85	84	87	89	89	89	88	88	88
SO2	AVERAGE (PPM)	.010	.006	.007	.005	.005	.006	.007	.006	.006	.007	.006	.005
	STANDARD DEVIATION	.019	.016	.015	.009	.010	.014	.015	.015	.016	.015	.015	.017
	CASE COUNT	88	89	87	89	91	91	91	91	91	91	91	91
NO2	AVERAGE (PPM)	.006	.004	.003	.008	.014	.019	.019	.028	.044	.054	.055	.054
	STANDARD DEVIATION	.023	.022	.019	.021	.024	.026	.029	.033	.037	.043	.042	.044
	CASE COUNT	59	59	55	56	58	58	62	62	62	62	62	62
SOL. RAD.	AVERAGE (LANGLEYS)	.876	.871	.820	.722	.580	.403	.227	.072	.003	0.000	0.000	0.000
	STANDARD DEVIATION	.307	.313	.276	.267	.223	.168	.100	.034	.005	0.000	0.000	0.000
	CASE COUNT	95	95	95	96	96	96	96	96	96	96	96	96
RH	AVERAGE (PERCENT)	48.928	46.811	45.434	44.564	44.387	45.639	47.308	50.419	56.289	61.330	64.765	67.149
	STANDARD DEVIATION	14.303	14.238	14.209	14.400	15.543	16.308	16.262	16.082	15.867	15.881	15.857	15.812
	CASE COUNT	95	95	95	96	96	96	96	96	96	96	96	96

APPENDIX C

STATISTICAL AIR QUALITY DATA IN ST. LOUIS II
7 OCT 71 TO 20 DEC71

HOURS --		0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100
OZONE	AVERAGE (PPM)	.005	.005	.007	.007	.007	.007	.004	.003	.003	.007	.012	.016
	STANDARD DEVIATION	.008	.008	.010	.009	.010	.012	.006	.006	.005	.007	.010	.012
	CASE COUNT	69	69	69	69	69	69	69	65	60	55	59	67
SO2	AVERAGE (PPM)	.006	.006	.005	.004	.004	.004	.006	.004	.006	.011	.012	.012
	STANDARD DEVIATION	.013	.012	.011	.011	.010	.009	.014	.012	.012	.020	.023	.025
	CASE COUNT	68	68	68	68	68	68	68	63	59	58	59	64
NO2	AVERAGE (PPM)	.033	.030	.026	.024	.022	.021	.027	.034	.038	.038	.032	.029
	STANDARD DEVIATION	.020	.019	.018	.017	.016	.015	.015	.019	.025	.031	.031	.027
	CASE COUNT	66	66	66	66	66	66	66	66	65	63	52	47
SOL. RAD.	AVERAGE (LANGLEYS)	0.000	0.000	0.000	0.000	0.000	0.000	.001	.036	.149	.270	.383	.450
	STANDARD DEVIATION	0.000	0.000	0.000	0.000	0.000	0.000	.002	.039	.105	.172	.228	.259
	CASE COUNT	74	74	74	74	74	74	74	74	74	73	73	72
RH	AVERAGE (PERCENT)	74.697	75.323	75.976	77.441	78.720	78.808	78.746	79.316	75.249	78.797	73.650	58.987
	STANDARD DEVIATION	13.660	13.783	14.038	13.845	14.078	14.293	14.188	14.960	15.387	16.558	17.987	17.755
	CASE COUNT	73	73	73	73	73	73	73	73	73	73	73	72

HOURS --		1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
OZONE	AVERAGE (PPM)	.019	.022	.022	.019	.013	.008	.005	.004	.004	.005	.004	.004
	STANDARD DEVIATION	.015	.017	.019	.018	.017	.013	.008	.007	.008	.008	.007	.007
	CASE COUNT	69	69	69	67	68	69	69	69	69	69	69	69
SO2	AVERAGE (PPM)	.010	.011	.009	.008	.008	.006	.005	.006	.004	.005	.005	.005
	STANDARD DEVIATION	.018	.021	.018	.018	.016	.013	.012	.014	.008	.010	.009	.010
	CASE COUNT	65	65	64	65	67	67	68	68	68	68	68	68
NO2	AVERAGE (PPM)	.025	.022	.023	.026	.032	.039	.044	.043	.041	.038	.038	.035
	STANDARD DEVIATION	.018	.012	.011	.012	.015	.018	.022	.024	.025	.022	.022	.021
	CASE COUNT	48	58	59	61	61	62	65	66	66	66	66	66
SOL. RAD.	AVERAGE (LANGLEYS)	.450	.415	.349	.240	.109	.032	.001	0.000	0.000	0.000	0.000	0.000
	STANDARD DEVIATION	.271	.271	.243	.194	.134	.055	.004	0.000	0.000	0.000	0.000	0.000
	CASE COUNT	72	71	72	71	74	74	74	74	74	74	74	74
RH	AVERAGE (PERCENT)	56.245	73.864	67.943	72.349	54.512	57.703	61.912	65.486	67.943	69.958	71.467	72.854
	STANDARD DEVIATION	19.336	16.469	10.358	16.139	21.539	20.694	18.548	16.960	15.833	15.342	15.023	14.622
	CASE COUNT	72	72	73	72	73	73	73	73	73	73	73	73